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ABSTRACT

A new construct, the Science Locus of Control (SciLOC) Orientation, was examined as a predictor of attitudes toward science teaching among 108 preservice elementary teachers. It is postulated that each person holds beliefs regarding the degree of his or her personal control in situations where decision, actions, or other modes of performance require either the application of scientific knowledge or the employment of inductive or deductive reasoning skills associated with scientific thinking. These beliefs give rise to behaviors, including expressed attitudes, which reflect the control orientation. Multiple regression analysis was employed to demonstrate that up to 47 percent of the variance in expressed attitudes toward science teaching can be explained by SciLOC orientation. Further analysis indicated that up to 24 percent of the variance in SciLOC orientation can be explained by differences in quantitative comprehension, sex, age, father's occupation, ethnicity, and high school size. These results are interpreted as evidence that SciLOC orientation is a major contributor to expressed attitudes toward science teaching among preservice elementary teachers and that it is influenced by a variety of factors related to academic and cultural experiences. (Author/JN)

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The Contribution of Science Locus of Control Orientation to Expressions of Attitude Toward Science Teaching

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Abstract

A new construct--Science Locus of Control (SciLOC) Orientation--was examined as a predictor of attitudes toward science teaching among 108 preservice elementary teachers. It is postulated that each person holds beliefs regarding the degree of his or her personal control in situations where decisions, actions, or other modes of performance require either the application of scientific knowledge or the employment of inductive and deductive reasoning skills associated with scientific thinking. These beliefs give rise to behaviors, including expressed attitudes, which reflect the control orientation. Multiple regression analysis was employed to demonstrate that up to 47% of the variance in expressed attitudes toward science teaching can be explained by SciLOC orientation. Further analysis indicated that up to 24% of the variance in SciLOC orientation can be explained by differences in quantitative comprehension, gender, age, father's occupation, ethnicity, and high school size. These results are interpreted as evidence that: (a) SciLOC orientation is a major contributor to expressed attitudes toward science teaching among preservice elementary teachers, and (b) SciLOC orientation is influenced by a variety of factors related to academic and cultural experiences.

Introduction

A chorus of voices has expressed concern in recent years for the plight of precollegiate science education (National Academy of Sciences & National Academy of Engineering, 1982; National Science Foundation & Department of Education, 1981; Walsh & Walsh, 1980; Wirszup, 1981; Wolk, 1983), with science education advocates urging schools to recognize science as a basic component of quality education (Commerce Technical Advisory Board, 1980; Harms & Yager, 1981). Massive Federal spending on curriculum projects during the Sputnik era proved inadequate to prevent a decline of student performance or interest in science (National Assessment of Educational Progress, 1978), to overcome

the illiteracy in science described by Bailey (1957), or to bridge the communication gap between the two cultures of science and the humanities (Snow, 1956). Curricular efforts and public endorsements of science education have enjoyed limited success, perhaps, because the nature and extent of science instruction in schools are determined primarily by what individual teachers believe, know, and do (DeRose, Lockard, & Paldy, 1979; Harms, 1981; Trojcak, 1982).

Reluctance to teach science was found widespread among elementary school teachers two decades ago (Blackwood, 1964) and remains so today (Pratt, 1981; Shymansky & Green, 1982), even though promotion of postive attitudes toward science teaching has been declared a priority for training programs (American Association for the Advancement of Science, 1970; Yager, 1978). In the search for factors influencing attitudes, investigators have examined the contributions of early field experiences for student teachers (Weaver, Hounshell, & Coble, 1979), demonstrated science knowledge (Shrigley, 1974b), proficiency in what are called the process skills of inquiry (Riley & Schaffer, 1979), and similar variables. Following a review of such studies, Morrisey (1981) suggested that more attention be given to dimensions of personality which may be related to expressed attitudes.

Among personality variables of potential interest are such factors as motives, personal conceptions, social characteristics, and measures of adjustment. Reviews of studies focusing on

personality (Balzer, Evans, & Blosser, 1973; Simpson, 1978; Sipe & Farmer, 1982) reveal the dominant theme of such research to be the effects of student and teacher characteristics on student performance and achievement. Seldom considered are the relationships between teacher personality characteristics and teacher behavior or expressions of attitudes. One promising line of inquiry in this regard has to do with the personal concerns teachers express.

Fuller (1969) has ranked teacher concerns, in order of decreasing personal priority, as follows: concerns about self, concerns related to tasks or role as a teacher, and concerns for student needs. The hierarchy implies that teachers attend minimally to student needs if concerns about self and role expectations remain unresolved. Indeed, concerns about self seemingly contribute to teacher anxiety (Keavney & Sinclair, 1978). Given Victor's (1962) finding that teachers fear a loss of classroom prestige when they teach science, the priority of concerns inferred by Fuller may account in part for the reluctance many elementary teachers have toward teaching science. Prestige and other aspects of self-image are likely matters of great concern which must be resolved before instructional time is committed to science.

Extending the work of Mead and Metraux (1957) regarding stereotypes of scientists, Brush (1979) has provided evidence that people who pursue repeated exposure to science tend to have

a self-image different from those who avoid such exposure. Among teachers, self-image is likely related to personal conceptions of expertise and ability, for studies have shown that teachers devote more instructional time to subject matter associated with areas of personal expertise (Cunningham & Blankenship, 1979; Hone, 1970). Less than surprising, this finding seems to support a basic principle of motivation characterized by Rawls (1971) as the "Aristotelian Principle". Elaborating on Aristotle's maxim that men desire to know, Rawls has suggested that people enjoy performing a task more as they gain proficiency. In his thinking, the principle constantly influences conscious activity and explains why certain tasks are preferred over others, with people valuing activities where talents can be manifested. For many teachers, seemingly, science teaching is not such an activity. In formal terms, many elementary teachers may perceive themselves as having little personal instrumentality or control in classroom situations involving science instruction. Self-conceptions regarding control are well characterized by the locus of control (LOC) construct (Rotter, 1966).

Essentially, LOC has to do with the strength of one's belief that personal actions influence the outcome of events, with the emphasis being on belief rather than the degree of control one actually possesses. Assuming there to be a continuum of belief orientations, people who tend to perceive the outcome of events as being contingent upon their own behavior are said to have an

internal LOC; conversely, those who do not perceive the outcome of events as being contingent upon their own behavior are said to have an external LOC. Studies elucidating the construct have been frequently reviewed, with one of the most recent treatments being that of Stipek & Weisz (1981). Following the suggestions of Rotter (1975) and Lefcourt (1976) that area-specific instruments be constructed in order to render the construct more utilitarian, several measures were developed having clinical value (Guskey, 1981; Hill & Bale, 1981; Wallston & Wallston, 1981). The challenge of constructing a scale to assess control orientations in situations requiring familiarity with science concepts and processes seemed to me worth pursuing.

Background

Results discussed here have been extracted from a more comprehensive study which included: explication of the science locus of control (SciLOC) construct; construction of two forms of an instrument designed to measure SciLOC orientation, the Locus of Control in Science (LOCIS) Scale; construction of an instrument measuring Expressed Attitudes Toward Teaching Science (EATTS Scale); a search for predictors of SciLOC orientation; and the effect of instructional treatment on SciLOC orientation. The focus of this report is on the contribution of SciLOC orientation as measured by the LOCIS Scale on expressions of attitudes toward science teaching as measured by the EATTS Scale. Also considered are some predictors of SciLOC orientation.

Methodology and Findings

Subjects of this study were students in a science methods course for preservice elementary teachers. Of 112 students composing four sections of the course, 108 were consenting subjects--91 females and 17 males. Due to subject mortality and incomplete participation by some subjects, the effective sample was reduced to 98 subjects, 90.7% of those consenting. Refer to Appendix A for a more complete statistical profile of the 112 students.

Instrumentation included the LOCIS I and LOCIS II Scales, and the EATTS Scale. The two forms of the LOCIS Scale each consisted of 18 items, with LOCIS I Scale items having a dyadic forced-choice format, and LOCIS II Scale items having a five-point Likert scale format (see Appendix B). Cronbach's coefficient alpha as computed by the Statistical Package for the Social Sciences (SPSS) subprogram RELIABILITY (Hull & Nie, 1981) was used to measure homogeneity, yielding estimates of .73 and .75 for the LOCIS I and LOCIS II Scales respectively. Using a separate sample of 53 subjects--also preservice elementary teachers enrolled in a science methods course--an estimate of concurrent reliability for the two scales was obtained by correlating the performance of subjects on the two scales when administered simultaneously. This procedure yielded a coefficient of $r = .63$ ($p < .001$). Other estimates of

reliability and a discussion of LOCIS Scale validity--including content, criterion-oriented, and construct validity--have been presented elsewhere (Haury, 1983).

The EATTS Scale, comprising three 10-item subscales, was analyzed both as a single comprehensive scale and as three independent scales. Exhibiting an overall reliability of .93, the EATTS Scale comprises: an Aspiration Subscale exhibiting a reliability of .86, an Anxiety Subscale exhibiting a reliability of .85, and a Supportiveness Subscale exhibiting a reliability of .82. Both the format and item content of the EATTS Scale reflect the influence of Redford's (included in Mayer, 1974) scale of Attitudes Toward Science and Science Teaching, and is representative of an approach commonly employed (Moore, 1973; Moore & Sutman, 1970; Shrigley, 1974a) to examine attitudes held among preservice elementary teachers. The EATTS Scale matches the LOCIS II Scale in format, with items consisting of statements to which subjects register the degree of their agreement or disagreement on a five-point Likert scale (see Appendix C).

Data collection procedures involved administration of the LOCIS I Scale on the first day of class for the science methods course, administration of the LOCIS II and EATTS Scales immediately after completion of the final examination for the course, and a review of selected student records. Course performance variables were obtained from the methods course instructor, descriptors of academic history were obtained from

college and high school transcripts, and a variety of background data were obtained from a teacher certification database. Once collected, all information was coded for computer manipulation using SPSS software.

It was during the attempt to demonstrate the construct validity of the LOCIS Scale that the contribution of control orientation to expressed attitudes was explored using multiple regression techniques. In accounting for variance in EATTS Scale total score, the contributions of several variables were examined: LOCIS II Scale score, subject gender, subject ethnicity, subject age, and performance on the methods course quizzes. As suggested by Kerlinger and Pedhazur (1973), dummy coding was used to transform categorical variables--gender and ethnicity--into a form that could be accommodated by regression analysis. Version 8 of the SPSS subprogram REGRESSION (Academic Computing Center, 1980) was used to perform the multiple regression analyses.

As shown by Tables 1 and 2, 47% of the variance in EATTS Scale total score can be explained by LOCIS II Scale score variance, while all five predictor variables together account for 49.4% of the variance. SciLOC orientation, then, as measured by the LOCIS II Scale, accounts for a major proportion of the variance in expressed attitudes as measured by EATTS Scale performance, with more positive attitudes being associated with greater internality.

Table 1

Summary of Steps When EATTS Total Score is Regressed on Selected Variables

Step	Variable	r[a]	R[b]	R^{2c}	F[d]	p[e]
1	LOCIS II Score	.69	.69	.47	76.14	.00*
2	Ethnicity	.03[f]	.69	.48	39.55	.00*
3	Gender	.14[g]	.70	.49	26.69	.00*
4	Age	.11	.70	.49	20.20	.00*
5	Quiz Points[h]	.12	.70	.49	16.00	.00*

Note. Listwise deletion of missing data was employed (cases were deleted from analysis if data were missing for any of the variables involved), leaving 88 of the 108 consenting subjects (81.5%) in the analysis.

[a] r represents the simple correlation between each predictor variable and the variable being regressed.

[b] R represents the multiple correlation as variables enter the regression equation at each step.

[c] R^2 represents the proportion of total variance in the variable being regressed that is explained at each step.

[d] F represents the F-ratio achieved at each step.

[e] p represents the probability of the expressed relationship at each step due to chance.

[f] Ethnicity is dummy coded to indicate membership in a nonwhite ethnic group.

[g] Gender is dummy coded to indicate identity as a male.

[h] Performance on science methods course quizzes.

* $p < 0.001$.

Table 2

Multiple Regression Weights of Variables Predicting EATTS Total Score

	Variables				
Parameter	1	2	3	4	5
b[b]	1.13	- 4.08	- 3.21	- .20	.02
SE[c]	.16	2.70	2.89	.21	.08
F	71.30	2.29	1.24	.88	.09
p	.00	.13	.27	.35	.77
Beta[d]	.71	- .12	- .09	- .08	.02
sp[e]	.47	.01	.01	.01	.00

Note. Variables are listed in order, from left to right, of inclusion in the regression equation. R^2 = .49. R^2 does not equal the sum of individual squared semipartials due to rounding errors.

[a]Variables have been numbered as follows: 1 = LOCIS II Scale Score, 2 = Subject Ethnicity, 3 = Subject Gender, 4 = Subject Age, and 5 = Performance on Course Quizzes.

[b]b represents the nonstandardized regression coefficient.

[c]SE represents the standard error of b.

[d]Beta represents the standardized regression coefficient.

[e]sp^2 represents the squared semipartial correlation.

Given the apparent contribution of SciLOC orientation to expressions of attitudes, one has to wonder what factors contribute to the adoption of a particular SciLOC orientation. In addressing that issue, predictors of LOCIS I Scale performance were sought among the available background variables and indicators of academic experience. Because generalized internality seems affected by socioeconomic status (SES) and ethnicity, these variables were assumed to contribute somewhat to LOCIS I Scale performance. Scores on the quantitative portion of the California Achievement Test (CAT) were also expected to contribute to variance in LOCIS I Scale performance given the role of quantification in science. General measures of achievement (verbal CAT scores and cummulative GPA), gender, and age were not expected to contribute significantly to LOCIS I Scale performance.

Following selection of relevant variables, multiple regression analysis proceeded in two stages. During stage one, three separate analyses were conducted to identify the strongest predictors from among three logical clusters of variables--measures of academic experience in science, measures of general academic performance, and an assortment of organismic and SES factors implicated in the literature as having an influence on LOC orientation. There seemed no basis for stipulating the order of variables in regression equations, so a stepwise procedure was followed whereby the variable accounting for the greatest proportion of unexplained variance at each step was added to the expanding equation.

The second stage of regression analysis consisted of developing a single regression equation using the strongest predictors from each logical cluster of variables. Using many variables with relatively small samples of subjects tends to increase standard error (Kerlinger & Pedhazur, 1973), so a ratio of over ten subjects per variable was maintained for each analysis.

Results presented in Tables 3 and 4 show the effect of LOCIS I Scale score being regressed on the seven strongest predictors available. On the basis of data from 69.4% of the sample, a significant multiple correlation was obtained, with the selected variables accounting for 24% ($p = .005$) of the variance in LOCIS I Scale score. The relative contribution of each variable to the explained variance is not conclusive, however, since the regression weights of only gender and performance on the quantitative portion of the CAT are statistically significant (see Table 4).

Table 3

Summary of Steps When LOCIS I Scale Score is Regressed on Selected Variables

Step	Variable	r	R	R^2	F	p
1	QCAT[a]	.27	.27	.07	5.77	.019
2	Gender	- .23	.38	.14	5.94	.004
3	Age	.22	.42	.18	5.07	.002
4	Father's Occupation	- .04	.45	.21	4.52	.003
5	Ethnicity	.11	.48	.23	4.10	.003
6	High School Size	.12	.48	.24	3.48	.005
7	Mother's Occupation	- .08	.49	.24	2.95	.009

Note. Results are based on 75 cases (69.4% of the total sample) for which data were available for all variables included in the analysis.

[a]QCAT represents performance on the quantitative portion of the California Achievement Test.

Table 4

Multiple Regression Weights for Variables in Table 3 When Predicting LOCIS I Scale Scores

	Variables[a]						
Parameter	1	2	3	4	5	6	7
b	.12	- 2.94	.12	- 1.62	1.21	.22	.13
SE	.04	1.18	.08	.97	1.02	.30	.77
F	10.22	6.25	2.37	2.77	1.39	.54	.03
p	.00	.02	.13	.10	.24	.47	.87
Beta	.38	- .28	.17	- .22	.14	.08	.02
sp^2	.07	.07	.03	.03	.02	.01	.00

Note. Variables are listed in order, from left to right, of inclusion in the regression equation. R^2 equals .24. R^2 does not equal the sum of semipartials due to rounding errors.

[a]Variables have been numbered as follows: 1 = QCAT, 2 = Gender, 3 = Age, 4 = Father's Occupation, 5 = Ethnicity, 6 = High School Size, and 7 = Mother's Occupation.

Discussion

Expressions of positive attitudes toward science teaching as measured by the EATTS Scale were found strongly related to SciLOC orientation as measured by the LOCIS II Scale, with performance on the LOCIS II Scale explaining 47% of the variance in EATTS Scale performance. The combined contribution of ethnicity, gender, age, and course performance accounted for a additional 2% of the explained variance. Aside from supporting the validity of the LOCIS II Scale, this finding implicates SciLOC orientation as a potentially powerful moderator of teacher attitudes. In an effort to elucidate the apparent effect, control orientation in science should be considered as a moderating variable in studies of teacher attitudes, science anxiety, teacher concerns, and self-image. Antecedents of SciLOC orientation should also be sought.

The possible antecedents examined in this study--age, gender, an SES factor, and quantitative comprehension--were found to explain 24% of the variance in LOCIS I Scale score. Of the factors examined, quantitative comprehension was identified as the strongest predictor of SciLOC orientation, accounting for 7% of the variance in LOCIS I Scale score and being positively related to SciLOC internality. Given the seemingly strong association of SciLOC orientation and expressed attitudes herein described, this finding implicates competence in mathematics as a major factor influencing attitudes toward science and science

teaching--empirical evidence for the intuitive idea that skill in applying mathematical tools to science-related tasks is linked to perceptions of personal instrumentality.

The contribution of age to LOCIS I Scale performance was more pronounced than expected and should, perhaps, be explored further. Developmentally there seems little reason for expecting an age effect, but perhaps the phenomenon is related to a search for personal independence among student teachers. Age is also a correlate of many academic and professional life experiences which may contribute to variance in control orientation. Formal academic performance in college and high school, however, was not found to contribute significantly to control orientation. This finding seems counterintuitive at first glance, but it may be a function of restricted range since subjects in this study have very similar academic histories.

Finally, there remains unexplained 76% of the variance in SciLOC orientation. If SciLOC orientation has a strong influence on the attitudes expressed by elementary school teachers toward science teaching, we would do well to identify the determinants of control expectancies in science. If the relationship between SciLOC orientation and academic performance in science is shown to parallel the strong relationships between general LOC orientation and academic performance, there will be cause to pursue accommodation or modification of SciLOC orientations in the classroom.

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APPENDIX A: STATISTICAL DESCRIPTION OF THE SAMPLE

1. Age in Years (n = 107)
   M = 25.5 SD = 4.7 Range = 21 to 40

2. Verbal Score on CAT (n = 99)
   M = 64.0 SD = 5.1 Range = 48 to 70

3. Quantitative Score on CAT (n = 99)
   M = 71.0 SD = 10.5 Range = 37 to 85

4. Gender: 95 females and 17 males

5. Ethnic Identity (n = 112)

Group	Frequency	Percentage
Chicano or Latino	8	7.1
Black	1	.9
American Indian	1	.9
Asian	7	6.3
White	78	69.6
Other	2	1.8
Unknown	15	13.4

6. Size of Most Recent High School (n = 97)

Number of Students	Frequency	Percentage
Less than 250	7	7.2
251 to 750	20	20.6
751 to 1250	22	22.7
1251 to 1750	24	24.7
1751 to 2250	23	23.7
More than 2251	1	1.0

7. Mother's Occupation (n = 94)

Occupation	Frequency	Percentage
Educator	15	16.0
Other Helping Profession	8	8.5
Other Professional Having a College Education	8	8.5
Professional Without a College Education	12	12.8
Other	51	54.3

8. Father's Occupation (n = 96)

Occupation	Frequency	Percentage
Educator	12	12.5
Other Helping Profession	13	13.5
Other Professional Having a College Education	29	30.2
Professional Without a College Education	12	12.5
Other	30	31.3

9. Cumulative GPA in Current College Program (n = 95)
   M = 3.2 SD = .50 Range = .7 to 3.9

10. Cumulative GPA for all College Coursework (n = 109)
    M = 3.1 SD = .4 Range = 2.3 to 3.9

11. GPA for College Mathematics Coursework (n = 102)
    M = 3.0 SD = .7 Range = 1.1 to 4.0

12. GPA for College Science Coursework (n = 106)
    M = 2.8 SD = .7 Range = 1.0 to 4.0

13. Combined GPA for College Science and Mathematics Coursework (n = 100)
    M = 2.8 SD = .6 Range = 1.4 to 4.0

14. High School Cumulative GPA (n = 87)
    M = 3.3 SD = .5 Range = 1.7 to 4.0

15. GPA for High School Mathematics Coursework (n = 83)
    M = 2.9 SD = .7 Range = 1.4 to 4.0

16. GPA for High School Science Coursework (n = 83)
    M = 3.0 SD = .8 Range = 1.0 to 4.0

17. GPA for Combined High School Science and Mathematics Coursework (n = 83)
    M = 2.9 SD = .6 Range = 1.6 to 4.0

18. College Science GPA Discrepancy (n = 106)
    M = - .3 SD = .5 Range = -1.3 to .6

(Note: Discrepancy values indicate the valence and magnitude of the difference between GPA for all coursework and GPA for science or mathematics. A negative value indicates a science or mathematics GPA lower than overall GPA.)

19. College Mathematics GPA Discrepancy (n = 102)
    M = - .1 SD = .6 Range = -1.9 to 1.1

20. Combined College Science and Mathematics GPA Discrepancy (n = 100)
    M = - .3 SD = .4 Range = -1.3 to 0.9

21. High School Science GPA Discrepancy (n = 78)
    M = - .3 SD = .5 Range = -1.6 to .6

22. High School Mathematics GPA Discrepancy (n = 78)
    M = - .3 SD = .5 Range = -1.5 to 1.1

23. Combined High School Science and Mathematics GPA Discrepancy (n = 78)
    M = - .3 SD = .4 Range = -1.3 to .6

24. Credit Hours of College Science (n = 105)
    (Note: 3 extreme outliers have been deleted.)
    M = 19.6 SD = 15.1 Range = 0 to 83

25. Credit Hours of College Mathematics (n = 108)
    M = 7.3 SD = 5.3 Range = 0 to 29

26. Credit Hours of College Science and Mathematics Combined (n = 104)
    M = 26.7 SD = 16.7 Range = 9 to 103

27. Semesters of High School Science (n = 89)
    M = 4.2 SD = 1.9 Range = 2 to 8

28. Semesters of High School Mathematics (n = 89)
    M = 5.5 SD = 1.9 Range = 2 to 9

29. Semesters of High School Science and Mathematics Combined (n = 83)
    M = 2.9 SD = .7 Range = 1.4 to 4

30. Grade in Mathematics Methods Course (n = 106)
    M = 3.38 SD = .63 Range = 1.7 to 4.0

31. Grade in Science Methods Course (n = 111)
    M = 3.56 SD = .47 Range = 2.1 to 4.0

APPENDIX B: LOCIS Scales

Section I contains LOCIS I with items having a forced-choice format.

Section II contains LOCIS II with items having a Likert scale format.

The correlation with total scale score is indicated next to each item. Responses interpreted as representing internality are marked with an asterisk.

Section I: LOCIS I Scale

Your Thoughts About Science

This is an opinionnaire which helps us determine what different people believe about some matters related to science. Since opinions differ, there are no "right" or "wrong" responses to these items. All of the possible responses are probably "right" to some degree, so it is usually a matter of picking those that seem most "right" to you personally.

Each item consists of an incomplete sentence followed by two phrases which could be used to make the sentence complete. For each item, please select the phrase that you more strongly believe to be appropriate, regardless of what anyone else might think. In cases where the choice seems difficult, silently repeat each phrase to yourself in order to decide which "sounds" more like something you might say. Please indicate your response to each item on the response sheet provided. It is important that you indicate a response to each item. Thank You!

1. If I were unable to operate a microcomputer, it would most likely be
   A. because I do not have much luck operating machines
   *B. because I seem unable to think in a linear, sequential manner
   [r = .32]

2. I can attribute most of the good scores that I have received on science tests or assignments to
   A. good guessing
   *B. my own intelligence
   [r = .28]

3. When I receive the grade I had hoped for in a science course, it is primarily because
   *A. I knew what I needed to do and how to do it
   B. the instructor's expectations were clear and reasonable
   [r = .38]

4. People often do not get the recognition they might in science classes because
   A. course expectations are too high
   *B. they do not put in their best effort
   [r = .31]

5. I cannot be expected to make an intelligent decision about which weed killer to use on a lawn because
   *A. it would take too much time to learn all the necessary details
   B. the chemistry involved is too complicated for people like me
   [r = .31]

6. Most of the unsuccessful scientific research efforts are casualties of
   *A. insufficient expertise
   B. unexpected events
   [r = .24]

7. If I were to avoid reading a science magazine, it would most likely be
   *A. because I did not want to take the time or effort needed to read the magazine
   B. because the chances of finding articles that are both entertaining and readable are small
   [r = .33]

8. People generally do well in science courses whenever
   *A. they make a concentrated effort to study and complete assignments
   B. the required readings and other expectations are of reasonable difficulty
   [r = .31]

9. If I were to complete a science homework assignment very quickly, it would most likely be
   *A. because I tried hard to stay on task and finish it
   B. because it was not a very difficult assignment
   [r = .33]

10. If I were to perform poorly in a science course, it would most likely be
   *A. because I did not devote enough time or attention to the required work
   B. because my instructor could not explain things very well
   [r = .21]

11. If I were to attend a public lecture given by a famous biologist, I would probably
   A. be lucky to figure out the main points of the talk
   *B. understand much of what he or she said
   [r = .54]

12. I benefit most from science exhibits in a museum when
   A. there are people or graphics nearby to explain the exhibits
   *B. I rely on my own ability to interpret the exhibits
   [r = .27]

13. If I were to remember something I read in an article about space exploration, it would probably be
   A. because of the way it was presented in the article
   *B. because I tried hard to remember it
   [r = .44]

14. Careers in science may be demanding, but I could become a successful scientist or science teacher if
   A. I were fortunate enough to have enthusiastic instructors who could explain difficult concepts well
   *B. I seriously wanted to and would be willing to sacrifice the time needed to study
   [r = .30]

15. If I were to have trouble interpreting the weather map in my newspaper, it would be
    *A. because I had not taken time to figure out what the symbols mean
    B. because the information is not presented in a form that is easily understood
    [r = .30]

16. I would consider myself qualified to vote on energy and environmental issues only if
    *A. I had thoughtfully considered all available information
    B. someone more knowledgeable than me had explained the issues in simple terms
    [r = .24]

17. In order to make a personal decision about a matter involving genetic screening, I would
    A. need the advice of knowledgeable friends
    *B. trust my own judgement based on available information
    [r = .27]

18. For most people, having a productive garden depends primarily on
    *A. a personal understanding of plant growth and soil characteristics
    B. having plants that are supposed to be suitable for specific regions of the country
    [r = .22]

Section II: LOCIS II Scale

Your Thoughts About Science

This is an opinionnaire which helps us determine what different people believe about some matters related to science. Since opinions differ, there are no "right" or "wrong" responses to these items. All of the possible responses are probably "right" to some degree, so it is usually a matter of picking those that seem most "right" to you personally.

This section of the opinionnaire consists of a number of statements with which you may agree or disagree. Circle one of the five choices on the response sheet next to the number for each item to indicate your agreement or disagreement.

Here is an example:

College students have too much free time. SA A N D SD

SA = Strongly Agree
A = Agree
N = Neutral
D = Disagree
SD = Strongly Disagree

Circling the SA means you agree strongly with the statement; circling the A indicates that you agree somewhat with the statement; circling the N shows that you have no opinion or a neutral feeling about the statement; circling the D indicates that you disagree somewhat with the statement; and circling the SD means that you disagree strongly with the statement.

Thank you for responding honestly to these statements.

1. Human genetics is too complicated for people like me to understand. [r = .53]
   SA A N D *SD

2. In making a personal decision about a medical problem I would trust my own judgment on the basis of available information more than the advice of knowledgeable friends. [r = .30]
   SA* A N D SD

3. For me to solve a physics problem would be more accidental than the result of sound reasoning. [r = .28]
   SA A N D *SD

4. Whether or not I could explain an idea in science to a child would depend more on the ability of the child to understand than on my ability to explain. [r = .27]
   SA A N D *SD

5. DNA'S role in inheritance can be understood to some degree by most people. [r = .29]
   SA* A N D SD

6. Any difficulty I may have in understanding a science-related news item will more likely be due to my lack of knowledge than to its theoretical nature. [r = .32]
   SA* A N D SD

7. I would consider myself more competent than fortunate if I were able to complete a science experiment successfully. [r = .25]
   SA* A N D SD

8. Most scientific concepts are too complex for people like me to comprehend. [r = .46]
   SA A N D *SD

9. Making a scientific discovery is more often the result of persistent research than a matter of chance. [r = .16]
   SA* A N D SD

10. Most any adult can interpret graphed data after a little practice. [r = .42]
    SA* A N D SD

11. Most people need to consult a specialist in order to plan a nutritious diet. [r = .36]
SA A N D *SD

12. More scientific research efforts fail because of incompetent researchers than because of unexpected events. [r = .11]
SA* A N D SD

13. For me, good grades in science courses depend more on instructors having clear and reasonable expectations than on my study habits. [r = .57]
SA A N D *SD

14. Using a field guide to correctly identify a tree would for me be more a matter of good fortune than skill in observation. [r = .28]
SA A N D *SD

15. The probability of me purchasing a good personal computer would be greater if I took a dealer's advice than if I made direct comparisons on my own. [r = .42]
SA A N D *SD

16. Choosing sides on many environmental issues is for me like throwing dice, one solution seems as appropriate as another. [r = .46]
SA A N D *SD

17. Science homework which I complete quickly more accurately demonstrates my proficiency than how easy the assignments may be. [r = .32]
SA* A N D SD

18. If I had to select the science textbook for a class, I would be more confident of the analysis of science consultants than I would be of my own review of available materials. [r = .35]
SA A N D *SD

APPENDIX C: Expressed Attitudes Toward Teaching Science (EATTS) Scale

Individual items are identified as follows:

ANX = EATTS Anxiety Subscale item

ASP = EATTS Aspirations Subscale item

SUP = EATTS Supportiveness Subscale item

Subject response to each item is indicated by mean score between Ø (Strongly Agree) and 4 (Strongly Disagree). (i.e. A higher mean score indicates stronger disagreement with the statement.)

Directions for subjects follow

Attitudes Toward Science and Science Teaching

This part of the survey consists of a number of statements with which you may agree or disagree. Circle one of the five choices on the scale next to each statement to indicate your agreement or disagreement.

Here is an example:

College students have too much free time. SA A N D SD

SA = Strongly Agree
A = Agree
N = Neutral
D = Disagree
SD = Strongly Disagree

Circling the SA means you agree strongly with the statement; circling the A indicates that you agree somewhat with the statement; circling the N shows that you have no opinion or a neutral feeling about the statement; circling the D indicates that you disagree somewhat with the statement; and circling the SD means that you disagree strongly with the statement.

Thank you for responding honestly to this survey.

1.	If the opportunity arises, I will encourage other elementary school teachers to teach science.	ASP [.4] SA A N D SD
2.	Teaching would be more pleasant if elementary teachers were not expected to teach science.	ANX [3.5] SA A N D SD
3.	Science teaching is stimulating and challenging.	ANX [Ø.4] SA A N D SD
4.	Science teaching is more of a chore than a pleasure.	ANX [3.3] SA A N D SD
5.	If given the choice as a student teacher, I would prefer teaching science over any other subject.	ASP [2.2] SA A N D SD
6.	I am looking forward to teaching science in the elementary school.	ASP [.7] SA A N D SD
7.	Science is not an important subject in the elementary school curriculum.	SUP [3.7] SA A N D SD
8.	I hope I do not have to teach science regularly.	ASP [3.3] SA A N D SD
9.	Science lessons provide students opportunity to express creativity and ingenuity.	SUP [.6] SA A N D SD
1Ø.	Administrators should not require elementary school teachers to prepare science lessons.	SUP [3.4] SA A N D SD
11.	Science instruction should be reserved for those times when lessons more basic to a good education have been completed.	SUP [3.2] SA A N D SD
12.	I believe that I have the same scientific curiosity as a young child.	ANX [1.4] SA A N D SD
13.	I expect to be able to excite students about science.	ASP [.7] SA A N D SD

14. Science instruction is not relevant for many elementary students. SUP [3.5]
SA A N D SD

15. Only teachers of grades six through twelve should be concerned about teaching science. ASP [3.6]
SA A N D SD

16. I feel uncomfortable teaching a science lesson when another teacher is in the room. ANX [2.8]
SA A N D SD

17. Teaching science is personally rewarding. ANX [.7]
SA A N D SD

18. I would enjoy helping children construct science equipment. ANX [.8]
SA A N D SD

19. I hope to include more than the average amount of science instruction in my teaching. ASP [1.2]
SA A N D SD

20. Science is a subject that will be fun to teach. ANX [.8]
SA A N D SD

21. Experiential science lessons are too chaotic and messy to be of real benefit in the elementary classroom. SUP [3.5]
SA A N D SD

22. Most schools are devoting more than enough time to science activities. SUP [3.2]
SA A N D SD

23. Students in an elementary teacher education program should not be required to take a science methods course. SUP [3.5]
SA A N D SD

24. Elementary school science should be taught by specialists rather than by teachers of self-contained classrooms. ASP [3.0]
SA A N D SD

25. Unless the school where I work has an established science curriculum, I do not intend to teach science. ASP [3.5]
SA A N D SD

26. I have no desire to teach science.	ASP [3.5]	SA A N D SD
27. I become tense when I have to teach a science lesson.	ANX [3.1]	SA A N D SD
28. I am afraid that students will ask me science questions which I cannot answer.	ANX [2.5]	SA A N D SD
29. Elementary school teachers should not be required to teach science.	SUP [3.5]	SA A N D SD
30. Time spent studying science could be more profitably used studying other subjects.	SUP [3.2]	SA A N D SD